TURBINE CYCLE TEST PROCEDURES

INTERMOUNTAIN POWER SERVICE CORPORATION
Intermountain Generating Station (IGS) UNIT 2

3/6/02

Test Procedures for:

Turbine Cycle Heat Rate

HP Turbine Enthalpy Drop Test

HP Turbine Wheel Power

IP Turbine Enthalpy Drop Test

Need detailed test procedures

→ transfer details from test spec F2 back into this document

Details
- Leakage flows - packing
- retractable packing
- IP Cooling Steam
- INDIKON

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Revision #/ Date:
#0- 02/07/02

Cycle Isolation List
-typed up

PHD's markup

Posting Diagram

Calcs
- HP acceptance - penalties & incentives

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TEST PROCEDURE FOR TURBINE CYCLE HEAT RATE AND HP TURBINE EFFICIENCY TEST

1.0 INTRODUCTION

This procedure outlines the Turbine Cycle Heat Tests that will be conducted to demonstrate that the guaranteed performance requirements of the HP Turbine Contract have been satisfied. The tests will be conducted the Intermountain Power Service Corporation (IPSC) with a third party agency providing test support.

The third party test agency will supply test instrumentation to the requirements of ASME PTC 6, using the direct final feedwater flow method method. The test will be carried out in accordance with **ASME PTC 6 1996 "Performance Test Code on Steam Turbines"**, except as otherwise stated by IPSC.

2.0 OBJECTIVE OF TESTS

The main objective of the test is to determine the HP Turbine Efficiency and Wheel Power (equivalent electrical load), following the installation of the upgraded HP turbine to determine HP turbine contract penalties and incentives.

The following is a list of test objectives:
Turbine Cycle Heat Rate
HP Turbine Enthalpy Drop Test
HP Turbine Wheel Power (electrical load equivalent)
IP Turbine Enthalpy Drop Test
Boiler Feed Pump volute upgrade acceptance
Boiler Feed Pump Turbine Performance

In addition, there are several key relationships that must be established:

HP Turbine Bowl Pressure (1st stage pressure tap replacement) to throttle steam flow for turbine controls setup,
Final feedwater flow to throttle flow relationship (for controls as well as monitoring steam flow for safety valve

limitations)
Generator electrical output reconciliation with Station Instrumentation

3.0 HP TURBINE- CONTRACTUAL GUARANTEES

2.1 The HP Turbine section upgrade provided by ALSTOM are guaranteed to provide 92.2% HP turbine efficiency (main steam valve inlet to HP turbine exhaust) when operating the turbine with all control valves wide open.

3.2 The HP Turbine is guaranteed to provide a HP Turbine Wheel Power (electrical load equivalent)of 299.0 MW, at the new rated steam conditions

ALSTOM also guarantees that the swallowing capacity of the HP turbine at the specified conditions will be ?? lb/hr. The HP turbine steam swallowing capacity will be calculated from the main steam flow at inlet to the turbine stop valves, derived from measurements using the final feedwater flow section.

3.3 The HP Turbine is guaranteed not to exceed main steam flow of 6.975 Mlb/hr, at the new rated steam conditions.

Details of the penalties and incentives are listed in the Turbine Contract and Specifications.

4.0 SCOPE OF TESTS

4.1 Turbine Contractual Tests

The HP Turbine efficiency achieved from the rotor and diaphragm replacement will be verified by enthalpy drop tests. These tests will be conducted as soon as practicable after unit startup. Turbine contractual requirements states that the testing should be more completed within 8 weeks after the unit is re-synchronized. During these tests, the unit will operate as close as possible to the normal maximum operation conditions with all the nozzle control valves wide open. However if the unit is constrained in achieving maximum output, the tests will be conducted at a reduced throttle pressure with control valves wide open.

The results of the tests will be corrected (as appropriate) for any significant variations of the relevant throttle conditions from those specified, using correction factors agreed, in advance of the tests, before comparison with guarantees.

4.2 Benchmark Tests

Benchmark enthalpy drop tests will be taken periodically with station instrumentation from the time of initial startup of the turbine and the results recorded for reference purposes.

5.0 TEST PREPARATION

5.1 Plant Operation and Control

Before starting the performance tests on the turbine generator unit, all relevant plant automatic control systems are to be set and working effectively to achieve the required values and stability of the operating steam conditions.

All normally operating plant equipment will be in service and operating normally. This includes

All feed water heaters

Cooling Tower Fans

However, some equipment or systems are specifically requested by kept out of service due to hot water and steam consumption. These include the following:

Reheat Desuperheating Sprays

Air Preheat warming system

HVAC Heating System (supply from Unit 1)

5.2 Outage Activities

During the outage, IPSC will check all relevant instrument connections and make sure that they are suitable for use during the tests. Instrumentation lines will be blown down.

Pressure tapping points, which have been capped off, will need to be re-instated and piped down to convenient location. Any new pressure tappings, such as pressure at HP turbine inlet, will need to be installed during the outage.

The bore of thermowells will be checked for blockage and cleaned if necessary.

The boiler feed pump turbine steam extraction flow nozzles (2) will be installed. The final feed water flow nozzle will be inspected, cleaned and condition documented.

Station instrumentation used during the test will be calibrated by IPSC. High accuracy test instrumentation (provided by third party) will also be installed by IPSC personnel during the outage.

6.0 TEST INSTRUMENTATION

6.1 An Instrumentation List of the third party equipment is attached in Appendix 1

6.2 Pressure Measurement

High precision pressure transducers are to be calibrated to within 0.1% accuracy. All measured pressures will be corrected for the static water legs and, where appropriate, atmospheric pressure.

Several pressure points maybe multiplexed to one transducer through the use of a scannivalve, as long as measurements are taken and recorded every 1 minute.

Water leg correct heights will be provided. Atmospheric pressure will be measured using a precision barometer.

IPSC will blow down instrumentation lines down prior to test.

6.3 Temperature Measurements

All temperatures will be measured using calibrated continuous lead, Type E (chromel constantan) thermocouples (T/Cs) or platinum resistance thermometers (RTDs) located in thermowells.

T/Cs or RTDs are to use a cold junction electronic or real ice bath reference.

Thermalwells are to be brushed out to ensure no rust or residue exists. T/Cs or RTDs shall be spring loaded in the thermowell to ensure they are bottomed out.

Multiple temperatures measured at different locations but represent the same condition will be averaged together.

IPSC will provide all instrumentation plumbing associated with hookup.

6.4 Flow Measurement

The differential pressure across the feed water flow nozzles will be measured by duplicate 0.1% calibrated differential pressure transducers. All other subsidiary flowmeters will be measured by single 0.1% calibrated differential pressure transducers.

IPSC will provide all instrumentation plumbing associated with calibrated flow section

6.5 Electrical Load Measurement

The generator electrical load measurement will be obtained using three (3) precision watthour meters and associated readout equipment. Three calibrated (3) test potential transformers shall be provided. Indicating ammeters and voltmeters will also be connected to the secondary circuits for measurement. The station's current transformers will be used.

6.5 Data Acquisition System

All output signals from pressure, temperature and flow measurements will be recorded automatically using a computer controlled data acquisition system.

All measurements will be taken at a minimum frequency of once per minute.

5.6 Plant Flow Section Information

Final Feed Water Flow Nozzle- The final feed water flow is measured using a welded-in ASME primary flow section. Calibration of this flow section was completed by Alden Research Laboratory and the results are included as an attachment. This flow section will be inspected during an outage and cleaned.

BFPT Extraction Steam Flow Nozzle- The BFPT extraction steam flow nozzles (2) will be installed during a unit outage. Calibration of this flow section was also completed by Alden Research Laboratory and the results are included as an attachment.

Main Steam Attemperation Spray Flow- The main steam attemperation spray flow will be measured with a station pipe tap nozzle. The nozzle will be inspected prior to the test

Reheat Steam Attemperation Spray Flow- If possibly the reheat steam will be isolated. Otherwise, reheat steam attemperation spray flow will be measured with a station orifice.

7.0 CALIBRATION OF TEST INSTRUMENTATION

7.1 Third Party Instrumentation- High accuracy instrumentation shall be calibrated, before the tests, using standards traceable to National Standards. Re-calibration following the test, will take place if there is questionable data (due to discrepancies between station instrumentation or data that is out of line).

8.0 TEST PROCEDURE

8.1 Plant Operation and Safety

IPSC will designate a 'Test Coordinator' to setup and coordinate testing with IPSC Operations and will act as interface with the Third Party test Agency and Allstom.

The Operations Department will take any action needed to maintain safety and reliability, during the course of a test. The Test Coordinator will immediately advise the test personnel of any changes to the operating conditions or plant isolation.

8.2 Number and Duration of Tests

Two VWO (valves wide-open) performance tests, each of a nominal 1 hour duration will be carried out for turbine acceptance. The tests will be compared for repeatability. Repeat tests will be conducted if the results are inconsistent.

TEST SERIES (6):

Full Load Tests (2) @ VWO/ 2400 psig/ Load 975 MWg
96% Load Tests (1) @ VWO/ 2300 psig/ Load 930 MWg
92% Load Tests (1) @ VWO/ 2200 psig/ Load 890 MWg
87% Load Tests (1) @ VWO/ 2100 psig/ Load 850 MWg
95% Load Test (1) throttle contrled/ ~2300 psig/ Load 925 MWg

8.4 Frequency of Readings

Pressure and temperature readings will be automatically logged at intervals no greater than 1 minute.

8.5 Turbine Throttle Test Conditions

Turbine throttle test conditions shall not vary significantly over the range of individual tests of varying inlet pressures and temperatures. However, for test accuracy reasons, it is essential that the performance tests be conducted with all of the control valves in the fully open position. Test conditions must also be held steady as near to the proposed test values as possible for at least 1 hour before the start of the test. Further, the maximum permissible fluctuation of the inlet conditions from the mean during any one test run, as allowed by ASME PTC 6: 1996 are: -

TEST CONDITION	Max Permissible Fluctuation during Test
Steam Pressure before HP stop valve	+/- 6 psi (±0.25% psia)
Steam Temperature before HP stop valve	+/- 7 °

Note: By mutual agreement between all parties involved, it is acceptable to conduct tests with deviations outside the limit set out in the table.

9.0 CYCLE ISOLATION

9.1 Valve Isolation List

IPSC will produce a Valve Isolation List to identify the valves requiring closure for a turbine test. These identified valves, will then be closed or checked by Operations personnel and prior to the test.

10.0 CALCULATION OF RESULTS

The detailed calculation methods for the various tests are shown on the calculation sheets in Appendix II of this procedure.

10.1 Steam Tables

The 1997 steam tables will be used in the calculation of the test results.

10.2 Measurement Uncertainty

Measurement Uncertainty shall be calculated utilizing the high accuracy instrumentation and the station instrumentation provided.

10.3 Test Tolerances and Allowances

Details of the Test Tolerances and Allowances are listed in the Turbine Contract and Specifications.

10.4 Excessive Deterioration

Details of the Excessive Deterioration are listed in the Turbine Contract and Specifications.

10.5 Delayed Testing

If the tests are delayed beyond the recommended 8 weeks after re-synchronisation, a deterioration allowance

equal to the ASME guidance norm will be applied to the results. This allowance will be added arithmetically to the tolerance for measurement uncertainty.

Details of the Excessive Deterioration are listed in the Turbine Contract and Specifications